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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/594,907	08/07/2008	Takeshi Sakamoto	46884-5519 (232060)	8322

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DRINKER BIDDLE & REATH (DC)
1500 K STREET, N.W.
SUITE 1100
WASHINGTON, DC 20005-1209

EXAMINER	
JUNG, MICHAEL	

ART UNIT	PAPER NUMBER
2895	

NOTIFICATION DATE	DELIVERY MODE
11/09/2011	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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penelope.mongelluzzo@dbr.com

Office Action Summary	Application No.	Applicant(s)	
	10/594,907	SAKAMOTO ET AL.	
	Examiner	Art Unit	
	MICHAEL JUNG	2895	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *23 September 2011*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

5)☒ Claim(s) *1-19* is/are pending in the application.

5a) Of the above claim(s) *16-19* is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-15* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

12)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *20110727; 20101122*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action mailed on 10/01/2011 ("10-01-11 OA") has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 09/23/2011 ("09-23-11 Submission") has been entered.

In the 09-23-11 Submission, the Applicant amended the independent claim 1 to traverse the 35 U.S.C. 102(b) rejection of claims 1-5 as being anticipated by Naoki; 35 U.S.C. 103(a) rejection of claims 6-10, 14 and 15 as being unpatentable over Naoki; and 35 U.S.C. 103(a) rejection of claims 11-13 as being unpatentable over Naoki and further in view of Fukuyo. The Applicant amended the dependent claim 7 to traverse the 35 U.S.C. 112, 2nd paragraph rejection of claim 7.

The amendments to independent claim 1 have changed the scope of the claims 1, and consequently, the scope of its dependent claims 2-15.

Currently, claims 1-19 are pending of which non-elected apparatus claims 16-19 remain withdrawn. Amended claims 1-15 are examined on their merits.

Response to Arguments

1. Amendments to the independent claim 1 have overcome the 35 U.S.C. 102(b) rejection of claims 1-5 as being anticipated by Naoki; 35 U.S.C. 103(a) rejection of claims 6-10, 14 and 15 as being unpatentable over Naoki; and 35 U.S.C. 103(a) rejection of claims 11-13 as being unpatentable over Naoki and further in view of

Fukuyo. Nevertheless, the amended claims 1-15 required further consideration and search. The amendments necessitated new ground of rejection(s) for amended claims 1-15, so the Applicant's arguments are moot.

2. Amendments to the dependent claim 7 have overcome the 35 U.S.C. 112, 2nd paragraph rejection of claim 7.

Information Disclosure Statement

3. The information disclosure statements submitted on 07/27/2011 and 11/22/2010 are in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statements are being considered by the examiner.

Claim Rejections - 35 USC § 112

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

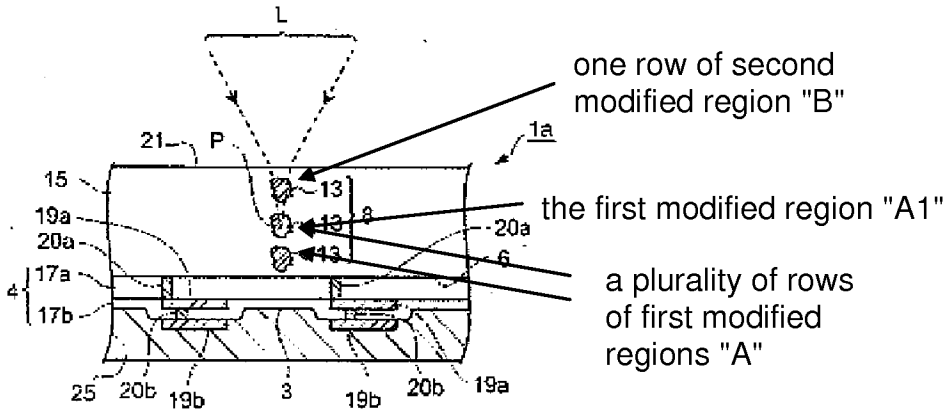
4. Claim 13 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 13 is indefinite, because claim 13 recites energy without appropriate unit of energy. For the purposes of advancing the examination, the examiner assumes the unit of energy to be microJoule (μJ).

Claim Rejections - 35 USC § 103

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

5. Claims 1-10, 14, and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Japanese Patent Pub. No. JP 2004-001076 to Naoki ("Naoki") in view of Patent No. US 7,005,317 B2 to Chin et al. ("Chin").



Annotated Drawing 23 of Naoki

Regarding claim 1, Naoki teaches a laser processing method (see Annotated Drawing 23 of Naoki) of

irradiating a substrate 15 (para [0075]) having a front face 6 (para [0052]) formed with a laminate part 4 (para [para [0022]) including a plurality of functional devices (para [0072] - "...the semiconductor layer laminated for elements exists in many cases...integrated circuit elements..."; see Annotated Drawing 23; see also para [0052].) with laser light L ("L" in Drawing 23; para [0022] discloses that "L" stands for laser beam.) while locating a light-converging point P of the laser light (see Annotated

Drawing 23 above) within the substrate 15 (para [0331]) so as to form a modified region 8 (para [0073] - "cut starting point domain") which functions as a start point for cutting within the substrate 15 along a cutting line (a line that overlaps the melting treatment regions 13 in the thickness direction of the substrate 15; para [0076] - "...If the crack by the melting treatment area 13 is grown up into the thickness direction...the wafer 1a can be also separated.) of the substrate 15,

the method comprising:

a first forming step of forming a plurality of rows of first modified regions A (see Annotated Drawing 23) along the cutting line; and

a second forming step of forming at least one row of a second modified region B (see Annotated Drawing 23) along the cutting line at a position between the first modified region A1 closest to a rear face 21 of the substrate 15 and the rear face 21 (see Annotated Drawing 23), so as to generate a fracture extending along the line to cut (para [0076] - "...If the crack by the melting treatment area 13 is grown up into the thickness direction...the wafer 1a can be also separated...") from the second modified 13 region to the rear face 21;

as a result of the second forming step, generating a fracture extending along the cutting line from the second modified region 13 to the rear face 21.

Naoki does not specifically disclose a method step of expanding an expandable film bonded to the rear face of the substrate; and as a result of the expanding step, cutting the substrate and the laminated part along the cutting line by advancing the fracture from the substrate to the laminate party by way of the first modified regions.

However, Chin teaches a method of singulating a semiconductor wafer by mounting a substrate 1 on an expandable film 8, 20 (col. 3, ln 50-59 - "FIG. 5 is a cross-sectional view of the substrate 1 having one side couple to a diaphragm 20 with an adhesive layer 8..."; col. 3, ln 60 - col. 4, ln 5 - "The adhesive layer 8 comprises a material having predetermined properties suitable for the particular purpose of coupling the substrate 1 to the diaphragm 20 during the singulation process."), initiating a fracture in the wafer (col. 4, ln 6-18 - "Suitable methods include…such as according with a pre-cut 16…using a laser 11"; see Fig. 6) and expanding the expandable film 8, 20 bonded to the substrate (see Fig. 7), resulting in singulated semiconductor dice (see Fig. 8). Chin teaches that singulating a semiconductor wafer using an expandable film 8, 20 can "provide the dice 2 with smooth edges and lower defect rate" (col. 6, ln 47-49). Chin teaches a need to "prevent unintentional fracture, cracking and delamination, that can be caused by the current singulation methods" (col. 2, ln 47-50).

At the time of the invention, it would have been obvious to one of ordinary skill in the art to combine the method of singulating a semiconductor wafer taught by Chin with the method taught by Naoki, with a reasonable expectation of providing semiconductor dice with smooth edges and lower defect rate (Chi, col. 6, ln 47-49) without intentional fracture, cracking and delamination (Chi, col. 2, ln 47-50).

As a result of the combination, the combined teachings of Naoki and Chi teaches the method step of expanding an expandable film (Chi) bonded to the rear face of the substrate 15 (Naoki); and

as a result of the expanding step, cutting the substrate 15 (Naoki) and the laminated part (Naoki) along the cutting line by advancing the fracture from the substrate 15 (Naoki) to the laminated part (Naoki) by way of the first modified regions (Naoki).

Regarding claim 2, Naoki further teaches the substrate 15 that is a semiconductor substrate (para [0052] - "semiconductors (Si)"), and the first and second modified regions A, B that include a molten processed region (para [0075] - "...melting treatment areas 13 are formed in the thickness direction of the substrate 15...").

Regarding claim 3, Naoki further teaches the first and second modified regions A, B that are successively formed one by one from the side farther from the rear face 21 while using the rear face 21 as a laser light entrance surface (see Annotated Drawing 23).

Regarding claim 4, Naoki further teaches the laser light that has an energy of 2 to 50 μJ (para [0032] - "Output: 20 microJ/pulse") when forming first modified regions A.

Regarding claim 5, Fukuyo further teaches the laser light that has an energy of 1 to 20 μJ (para [0032] - "Output: 20 microJ /pulse") when forming the second modified region B.

Regarding claim 6, Naoki discloses that the laser beam penetrates not less than 80% into the silicon substrate 15 (para [0035]). In other words, the energy of a laser beam attenuates as it penetrates into the silicon substrate 15. Thus, it would have been

obvious to one of ordinary skill in the art that it would take more energy to form a modified region deeper in the silicon substrate than to form shallower modified regions.

At the time of the invention, it would have been obvious to one of ordinary skill in the art to employ a laser light having a greater energy when forming the first modified regions than when forming the second modified regions as taught by Naoki, so as to keep the size of the modified regions relatively similar to each other as shown in Annotated Drawing 23.

Regarding claim 7, neither Naoki nor Chin specifies the energy of the laser light for forming the first modified region that is 1.6 to 3 times as large as the energy of the laser light for forming the second modified region.

However, Naoki teaches locally heating a substrate by depositing a laser power density between at least $1x10^{8}$ W/cm^2 and $1x10^{12}$ W/cm^2 to form a "melting treatment area" (para [0031]). Moreover, a pulse width of the laser is between 1 to 200 nanoseconds (para [0031]) and a laser light-spot cross-section area is $3.14x10^{-8}$ cm^2 (para [0032]). The product of the laser power density, the pulse width and the laser light-spot cross-section yields energy of the laser.

The energy of the laser is a result effective variable. In light of Naoki's teaching (see rejection of claim 6), it would have been obvious to one of ordinary skill in the art that it would take more energy to form the first modified region than the second modified region (that is, the first modified region is situated deeper in the substrate than the second modified region.), it would have been obvious to one having ordinary skill in the art at the time of the invention was made to select the energy of the laser for forming the

first modified region that is 1.6 and 3.0 times as large as the energy of the laser for forming the second modified region, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

Regarding claim 8, Naoki discloses the light-converging point P of the laser light L that is located in about half way in between the substrate in the substrate thickness direction. Since Naoki teaches that the substrate 15 can have various thicknesses such as 100 microns (para [0033] and [0034]), it would have been obvious to one of ordinary skill in the art that the respective portion where the light-converging point of the laser light is located when forming neighboring first modified regions 13, 13 have a distance of 24 to 70 microns therebetween.

Regarding claim 9, Naoki discloses the light-converging point P that is located in about half way in between the substrate in the substrate thickness direction. Since Naoki teaches that the substrate 15 can have various thicknesses such as 100 microns (para [0033] and [0034]), it would have been obvious to one of ordinary skill in the art that the light-converging point P of the laser light L is located at a position distanced by 50 micron to 180 micron from the rear face 21 when forming the first modified regions 13, 13.

Regarding claim 10, Naoki discloses the light-converging point P that is located in about half way in between the substrate in the substrate thickness direction. Since Naoki teaches that the substrate 15 can have various thicknesses such as 100 microns (para [0033] and [0034]), it would have been obvious to one of ordinary skill in the art

that the light-converging point P of the laser light L is located at a position distanced by 20 micron to 110 micron from the rear face 21 when forming the first modified regions 13, 13.

Regarding claim 14, Naoki discloses the light-converging point P that is located in about half way in between the substrate in the substrate thickness direction. Since Naoki teaches that the substrate 15 can have various thicknesses such as 100 microns (para [0033] and [0034]), it would have been obvious to one of ordinary skill in the art that the light-converging point P of the laser light L is located when forming the second modified region 13 closest to the rear face 21 of the substrate 15 is distanced from the rear face 21 by 20 micron to 110 micron, and a position where the light-converging point P of the laser light L is located when forming the second modified region second closest to the rear face 21 of the substrate is distance from the rear face by 140 microns or less (see Annotated Drawing 23).

Regarding claim 15, Naoki further teaches the step of cutting the substrate 15 and the laminate part 4 along the line to cut (para [0076]).

6. Claims 11-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Naoki and Chin and further in view of European Patent Pub. No. EP 1 338 371 A1 to Fukuyo ("Fukuyo").

Regarding claim 11, Naoki discloses that the laser beam penetrates not less than 80% into the silicon substrate 15 (para [0035]). In other words, the energy of a laser beam attenuates as it penetrates into the silicon substrate 15. Thus, it would have been

obvious to one of ordinary skill in the art that it would take more energy to form a modified region deeper in the silicon substrate than to form shallower modified regions.

At the time of the invention, it would have been obvious to one of ordinary skill in the art to employ a laser light having a greater energy when forming the first modified regions than when forming the second modified region as taught by Naoki, so as to keep the size of the modified regions relatively similar to each other as shown in Drawing 23.

Neither Naoki nor Chi explicitly discloses forming a plurality of rows of second modified regions.

However, Fukuyo teaches forming a plurality of rows of modified regions (see Fig. 92 for example) that is more than three rows as disclosed by Naoki.

At the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the method of forming modified regions of Naoki by forming more than three rows of the modified regions as taught by Fukuyo, so as to cut a thicker substrate and/or to make it easier to generate and extend a crack that reaches both sides of the substrate (Naoki, para [0036]).

Regarding claim 12, the modified method taught by the combination of Naoki, Chin and Fukuyo does not disclose the energy of the laser light for forming the second modified region farthest from the rear face of the substrate that is 1.3 to 3.3 μJ; or the energy of the laser light for forming the second modified region closest to the rear face of the substrate that is 1 μJ.

However, Naoki teaches locally heating a substrate by depositing a laser power density between at least $1x10^{8}$ W/cm^2 and $1x10^{12}$ W/cm^2 to form a "melting treatment area" (para [0031]). Moreover, a pulse width of the laser is between 1 to 200 nanoseconds (para [0031]) and a laser light-spot cross-section area is $3.14x10^{-8}$ cm^2 (para [0032]). The product of the laser power density, the pulse width and the laser light-spot cross-section yields the energy of the laser.

The energy of the laser is a result effective variable. In light of Naoki's teaching (see rejection of claim 6), it would have been obvious to one of ordinary skill in the art that it would take more energy to form the second modified region that is farthest from the rear face of the substrate than the second modified region that is closest to the rear face (that is, the second modified region farthest from the rear face is situated deeper in the substrate than the second modified region closest to the rear face.). Furthermore, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to select the energy of the laser for forming the second modified region farthest from the rear face of the substrate that is 1.3 and 3.3 μJ and the energy of the laser for forming the second modified region closest to the rear face of the substrate that is 1 μJ, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

Regarding claim 13, the modified method taught by the combination of Naoki and Fukuyo does not disclose the energy of the laser light for forming the first modified

region that is 1.3 to 3.3 μJ; or the energy of the laser light for forming the second modified region closest to the rear face of the substrate that is 1 μJ.

However, Naoki teaches locally heating a substrate by depositing a laser power density between at least $1x10^{8}$ W/cm^2 and $1x10^{12}$ W/cm^2 to form a "melting treatment area" (para [0031]). Moreover, a pulse width of the laser is between 1 to 200 nanoseconds (para [0031]) and a laser light-spot cross-section area is $3.14x10^{-8}$ cm^2 (para [0032]). The product of the laser power density, the pulse width and the laser light-spot cross-section yields the energy of the laser.

The energy of the laser is a result effective variable. In light of Naoki's teaching (see rejection of claim 6), it would have been obvious to one of ordinary skill in the art that it would take more energy to form the first modified region than the second modified region that is closest to the rear face (that is, the first modified region is situated deeper in the substrate than the second modified region closest to the rear face.). Furthermore, it would have been obvious to one having ordinary skill in the art at the time of the invention was made to select the energy of the laser for forming the first modified region that is 1.3 and 3.3 μJ and the energy of the laser for forming the second modified region closest to the rear face of the substrate that is 1 μJ, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

Conclusion

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. JP404252049A to Yasutake (English Translation of the Abstract is provided).

Amended claims 1-15 are rejected.

Withdrawn claims 16-19 remain withdrawn.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MICHAEL JUNG whose telephone number is (571)270-3345. The examiner can normally be reached on M-F from 8:30 AM to 8 PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Drew Richards can be reached on (571) 272-1736. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/MICHAEL JUNG/
Examiner, Art Unit 2895
02 November 2011

/N. Drew Richards/
Supervisory Patent Examiner, Art Unit 2895